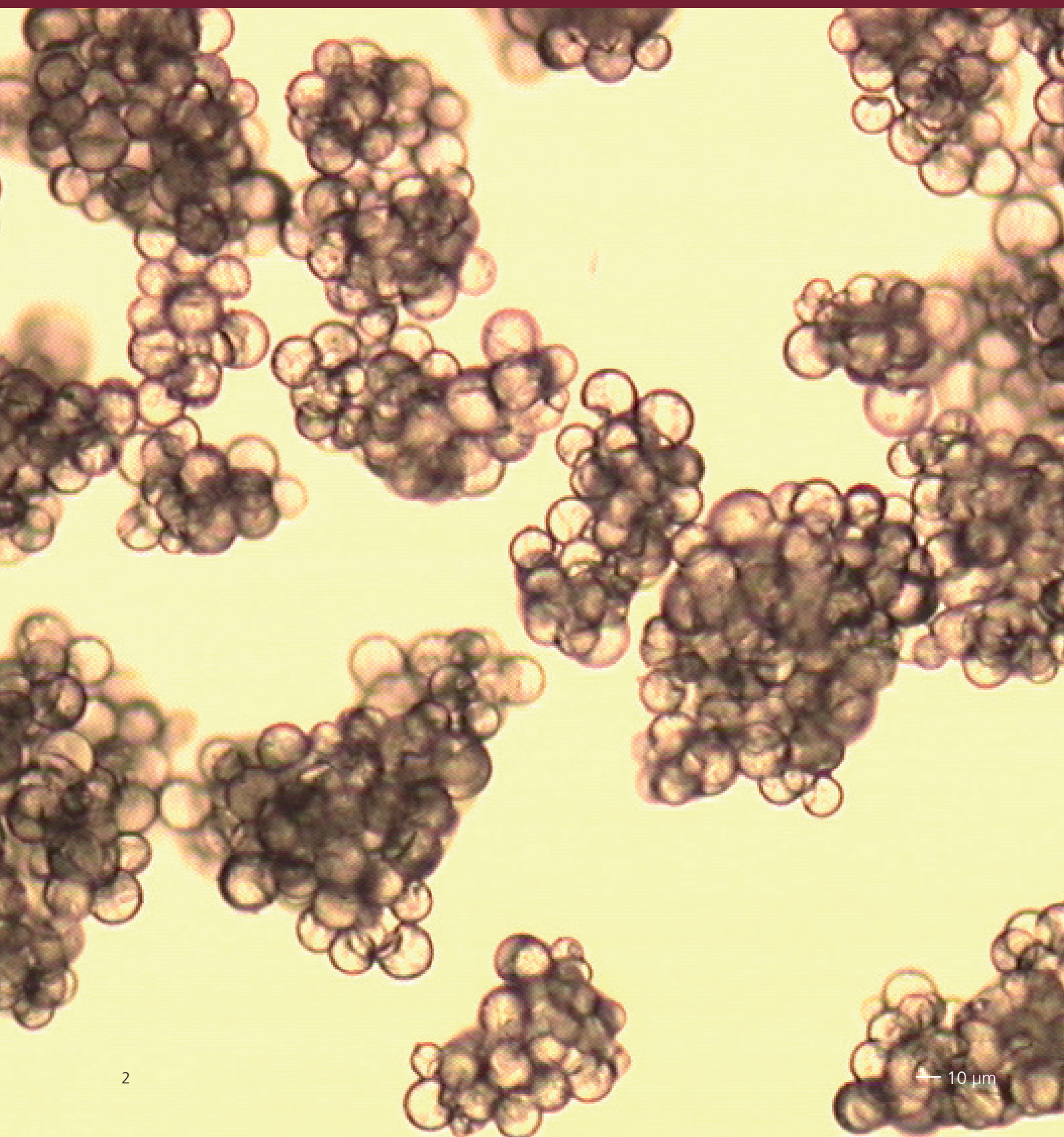


TECHNOLOGY PLATFORM MICROENCAPSULATION

GAIN ACCESS TO LATEST TECHNOLOGY KNOWLEGDE

MEET THE PERSONS IN CHARGE IN YOUR BUSINESS AREA

ACCELERATE YOUR INNOVATION POTENTIAL



CONTENT

TECHNOLOGY PLATFORM MIRCOENCAPSULATION	4
ACHIEVEMENTS	5
FUTURE PERSPECTIVE	7
FRAUNHOFER ICT	9
FRAUNHOFER IAP	11

TECHNOLOGY PLATFORM MICROENCAPSULATION

NETWORK

The objective of the technology platform microencapsulation is to achieve a strong cross-linking between science and industry organizations that deal with microencapsulation. The bond between industry and science is accomplished by the host of the platform, Fraunhofer ICT and Fraunhofer IAP.

RETURN OF YOUR INVESTMENT

Participants gain access to:

- Fraunhofer network (applied science)
- Who is who? Persons in charge in industry organizations who work with or are interested in microencapsulation technology
- Profitable applications? Information on latest published patents on the subject microencapsulation
- Technical advances? New and interesting developments through analysing publications
- Identification of experts including interviews
- Future perspective on the microencapsulation technology to get a feeling about the potential of the technology

APPLICATION FIELDS

Displays and surfaces; cosmetics and pharmacy; textile and paper; agriculture; industry and building; medicine, security and many others.

TECHNOLOGY FIELDS

Focus is laid on release mechanisms, materials used, manufacturing technologies and processing technologies. Additional aspects about Technology and Innovation management support the participants during their everyday challenges and to identify new areas of application in workshops and meetings.

PLATFORM ROADMAP

After starting in 2009, the technology platform microencapsulation continues in its 5th phase until the end of 2017. The experiences made during the last years make this cross-industrial technology-driven community even more excellent and for newcomers even more valuable to join.

COST

5000€ p. a.

PLATFORM MEMBERS

Quality and trustfulness are two cornerstones for this exclusive network. Therefore participating companies are selected carefully. Currently Fraunhofer Institute for Chemicals Technology Pfinztal ICT/Fraunhofer Institute for Applied Polymer Research IAP/Fraunhofer Research group "Particle technology and raw material innovation" TH Nürnberg FPR hosts (selection):

- BASF SE
- Clariant International Ltd.
- Follmann GmbH & Co. KG
- LANXESS Deutschland GmbH
- Lonza Ltd.
- Koehler Innovative Solutions
- Symrise AG

ACHIEVEMENTS

Each News Letter (NL) focused on a special topic in the field of microencapsulation. Other NL chapters include the TPM members corner, regularly updated information platforms and upcoming events and other interesting news and projects relevant to microencapsulation.

"NEWS LETTERS" 2009

- NL I: Overview about microencapsulated colorants and pigments for applications in food, pharmacy, textile, building and chemistry
- NL II: Overview about mechanisms of controlled release
- NL III: New developments and future perspectives for textile applications, new analytical methods and its potential for new markets.

"NEWS LETTERS" 2010

- NL I: Detailed description about encapsulation of food ingredients
- NL II: Microencapsulation of solid particles
- NL III: Main triggering systems to release microencapsulated active agents or additives

"NEWS LETTERS" 2011

- NL I: Mechanical stability of microcapsules and ways of evaluating the mechanical stability
- NL II: Asian research activities. Which company and which research facility is working in which field of microencapsulation?
- NL III: Thermally and mechanically stable microcapsules for polymer processing

"NEWS LETTERS" 2012

- NL I: Basic patent knowledge, patent screening and monitoring – case TPM patent update
- NL II: Freedom to operate – blackspot analyses
- NL III: Information database for microencapsulation

"NEWS LETTERS" 2013

- NL I: Trends in microencapsulation
- NL II: Triggered release of microcapsule content
- NL III: Mechanical stability of microcapsules incl. interview with Prof. Zhang

"NEWS LETTERS" 2014

- NL I: Functionalization and characterization of microcapsule surface properties
- NL II: Triggered release of microcapsule content – update
- NL III: Highlights of new market studies and trends in microencapsulation

"NEWS LETTERS" 2015

- NL I: Trends in microencapsulation – continued
- NL II: Barrier properties of microcapsule walls
- NL III: Impact of microcapsules and microparticles on the environment

ACHIEVEMENTS

ONLINE PLATFORM

All information is provided online. Members have access to patent and article analyses as well as "News Letters". Contact information about all participants also is available.

DATABASE

Database contains companies, products, R&D-institutions in the field of microencapsulation. The database will be updated regularly.

Bimonthly updated Patent- and Literature-Survey continued.

WORKSHOP 2015

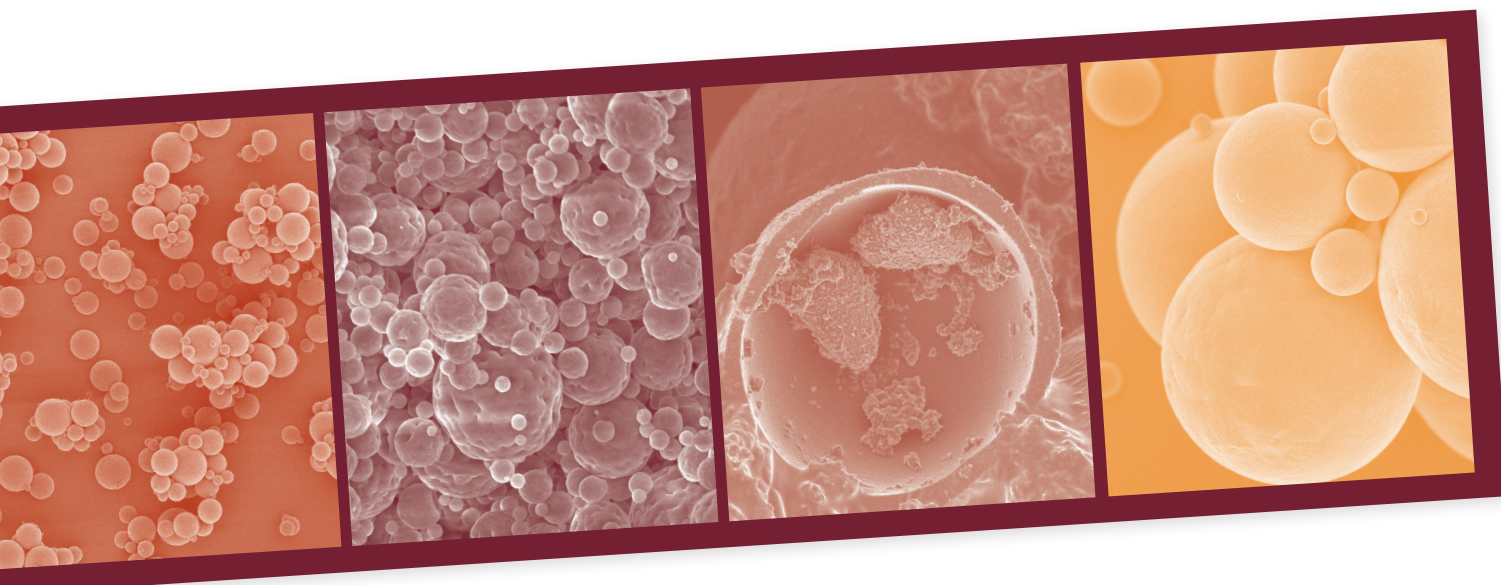
Workshop 25.3.2015 in Stuttgart
"Characterisation of microcapsules and microparticles"
with 10 expert speeches and poster exhibition

FRAUNHOFER DAY 2013

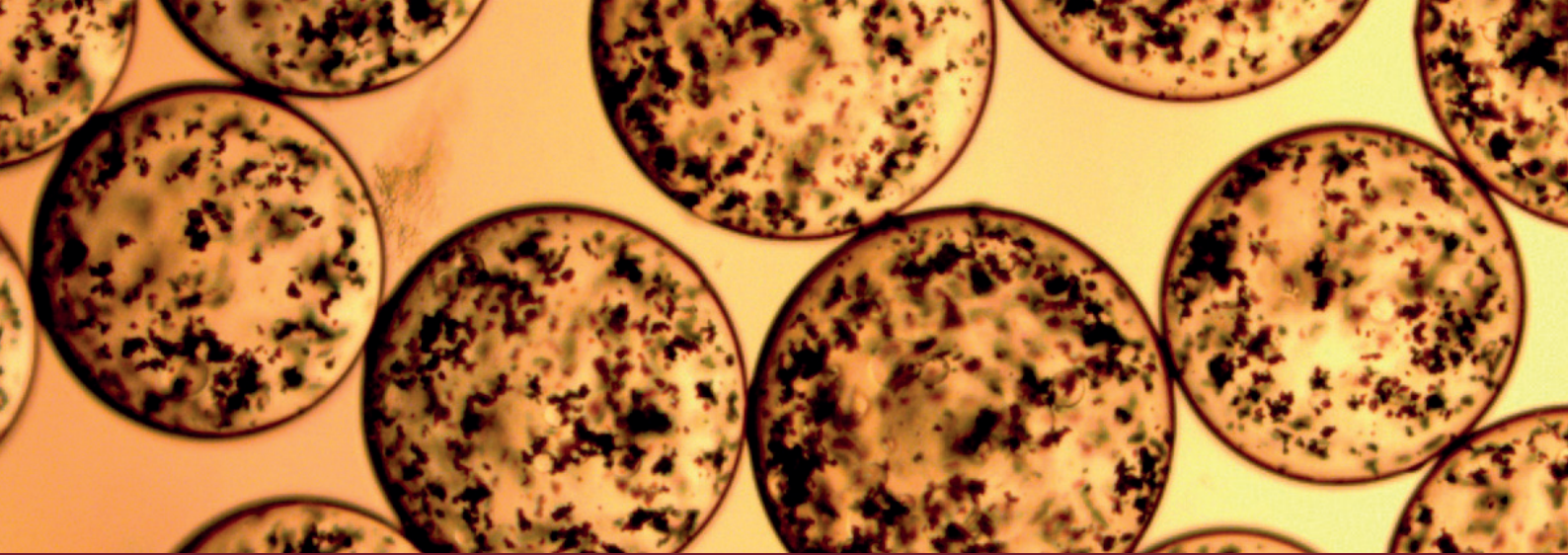
Fraunhofer Day 4.7.2013 in Munich
Symposium with 11 expert speeches and poster exhibition.
The following Fraunhofer Institutes showed their highlights in microencapsulation:
EMFT, IAP, IBMT, ICT, IFAM, IGB, IISB, ISC, ISE, IVV, UMSICHT.

IPEMTECH 2011

20.–21.11.2011 in Berlin
Symposium with 11 expert speeches and exhibition



[HTTPS://DMS-PREXT.FRAUNHOFER.DE](https://dms-prext.fraunhofer.de)



FUTURE PERSPECTIVE

CONTINUOUS GROWTH OF THE PLATFORM

The business model of the technology platform includes:

- The establishing of personal contacts
- Diffusion of technology knowledge through company and market barriers
- Access to latest developments in innovation and technology
- Information about latest encapsulation technology developments and applications

New high potential companies with basically three motivations are welcome:

- Companies which do research in the field of micro-/nano-encapsulation and/or particles
- Companies which value the potential of micro-/ nano-encapsulation and/or particles and monitor the technology
- Companies seeking partnerships, networks and business beside the information provided by the TPM

FUTURE TOPICS AND “NEWS LETTERS”

As a patent & article analysis is done every two months for the encapsulation field, some “News Letters” will discuss the information provided there in detail and show developments, newly addressed research aspects and trends. Combined with past analyses of patents & articles it is possible to build a roadmap of interesting developments. Additional expert interviews provide interesting interpretations of application fields and technological developments.

These “News Letters” are presented on top of detailed information of encapsulation techniques and technology.

Proposals for News letter topics 2016:

- Trends in microencapsulation (evaluation of papers and patents published in 2015)
- Microcapsule based self-healing – current status and prospects
- Microencapsulation of reactive components – gluing and sealing

Further proposals are welcome. The members will be contacted to vote for the topics.

NETWORKING

On top of “News Letters”, the community will meet once a year to have the chance to exchange exclusive ideas and acquire projects. In 2016, the TPM meeting will take place at Fraunhofer ICT Pfinztal to meet the new TPM platform hosts Fraunhofer ICT and FPR (Fraunhofer Research group “Particle technology and raw material innovation”, TH Nürnberg). A microencapsulation workshop is planned for 2017, the topic has to be specified.

FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT

The Fraunhofer Institute for Chemical Technology ICT, founded in 1959, is one of the largest and longest-established institutes of the Fraunhofer-Gesellschaft. At its headquarters in Pfinztal over 540 employees carry out research and development work in the fields of chemical and environmental engineering, polymer engineering, energy systems and explosives engineering. The total area of the institute in Pfinztal is 200,000 m². This includes 25,000 m² of laboratories, offices, pilot plants, workshops, test stands and other facilities. This exceptional research infrastructure, which includes high-volume pilot plants and industrial scale equipment, enables the institute to develop and implement new materials, processes and products up to near-industrial level. State-of-the-art laboratories, and all the necessary testing and analytical processes, are available for our research work in the five departments (Energetic Materials, Energetic Systems, Applied Electrochemistry, Polymer Engineering and Environmental Engineering).

MICROENCAPSULATION TECHNOLOGY AT FRAUNHOFER ICT

The Fraunhofer ICT has many years of experience in modifying the product properties of specialty and fine chemicals, pharmaceutical products and energetic materials (propellants and explosives) using particle technology.

Depending on the phase of the material system (solid/solid, liquid/liquid), the specific requirements placed on the materials (hazardous substances, sensitivity, availability/price) and the necessary throughputs, tailored processes are investigated and developed for the production and modification of particles according to customer requirements. These include in particular fluidized bed coating and continuous micro-encapsulation in microfluidic structures.

Besides drying, crystallization and milling processes, spray and emulsion methods, particle production with supercritical fluids,

micro and nanocomposite processes and coating technologies are also applied. Furthermore, particle and crystal structure analysis and molecular modelling complete our portfolio.

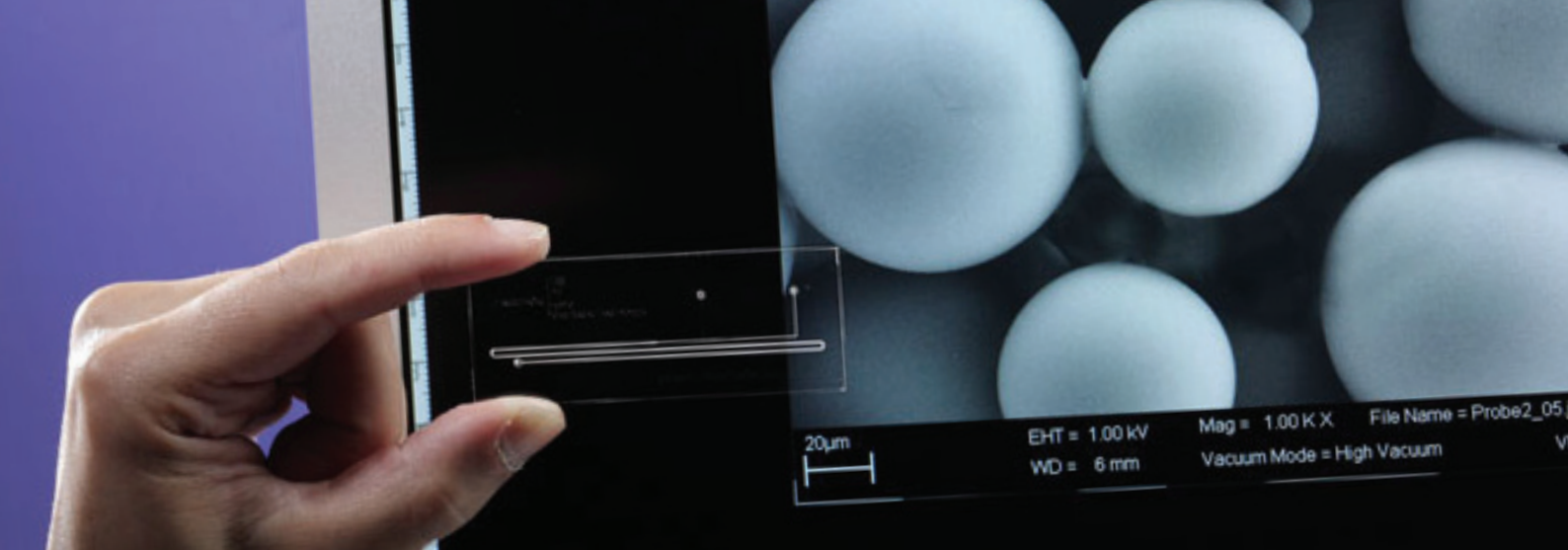
PARTICLE-COATING

For particle-coating fluidized-bed technology is used. Thin coating layers for tailored surface properties are applied to individual particles while avoiding agglomeration. The modified fluidized-bed units at the Fraunhofer ICT have been specially adjusted to the Institute's requirements, enabling the processing of explosion-sensitive and extremely hydrophobic core materials. Possible coating materials include dissolved polymers or dissolved crystalline substances. The dissolved coating material is sprayed onto the fluidized particles in the bed using a nozzle system. The appropriate solvents for the coating materials can be either aqueous systems or a variety of different organic solvents. Conditioned air or nitrogen can be used as a process gas. The devices used have a capacity for batch sizes from 200 g up to 5 kg.

The aim is to improve the particle properties of the core material through encapsulation with small quantities of coating materials. The following improvements can be made:

- Increasing the compatibility compared to reactive substances such as isocyanates
- Protection of hygroscopic materials from humidity and moisture
- Decreasing the sensitivity of energetic materials (desensibilization)
- Functionalization of particle coatings or composite particles by incorporating nanoscale substances, such as stabilizers, combustion modulators, bonding agents, conductive substances, CNTs etc.
- Increase in mechanical strength

Besides particle coating, fluidized-bed technology can also be used for spray drying, granulation and consequently for the production of composite materials containing micro and nano-structures resulting from the embedded nanoparticles.



MICROFLUIDIC PROCESSES

Micro-structured reactors can be used for the high-precision processing of multiphase systems in the form of segmented flows and unimodal emulsions.

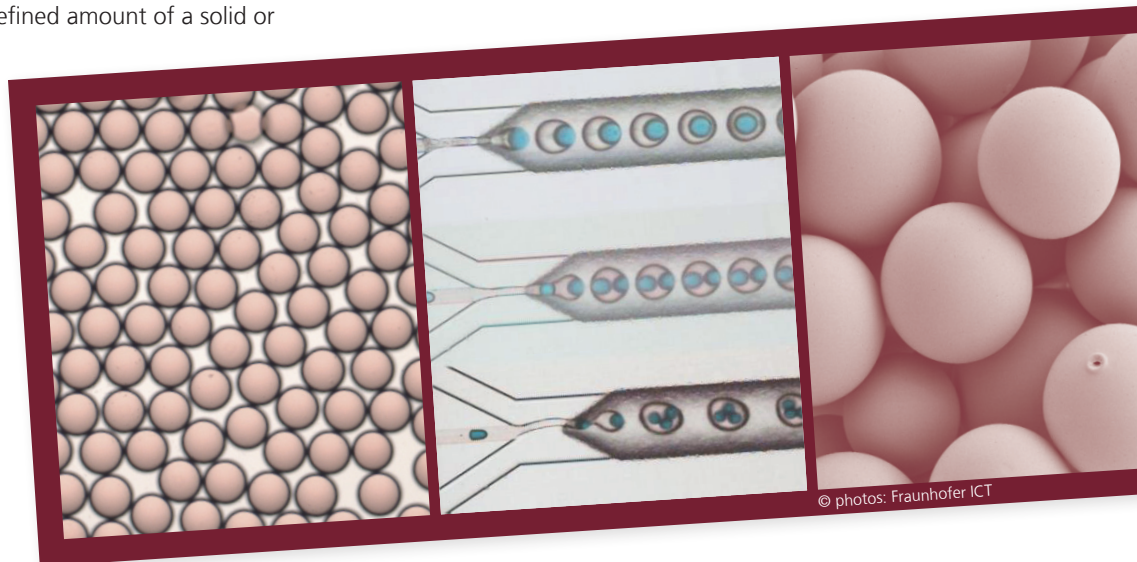
At Fraunhofer ICT these microfluidic technologies are used for manufacturing microscale particulate products. The precise control of the droplet size of emulsions which is achieved in microfluidic structures is used to synthesize monomodal spherical polymer particles in microreactors. With regard to various future applications the particles can be highly functionalized even during synthesis, for example by adjusting a particular porosity, by encapsulating active ingredients in the polymer network or by applying molecular imprinting techniques. The size of the polymer particles is infinitely adjustable over a broad range, e.g. between a few micrometers and several hundred micrometers.

The high precision in droplet formation also enables the formation of complex and highly regular multiple emulsions. On the basis of such emulsions polymer microcapsules can be manufactured with a solid shell approx. 100 nm thick. During the process the capsules can be filled with a well-defined amount of a solid or liquid material.

OUR OFFER

Drawing on our long-standing experience in product, process and technology development in the field of specialty and fine chemicals, we offer customer-specific support in the design and optimization of new products and processes.

- Feasibility and parameter studies on the production of functionalized particles and capsules
- Construction of prototypes, and validation on a laboratory and pilot scale
- Process development from the laboratory application through to pilot level, through the selection and adjustment of reactor technology and process control
- Execution of potentially hazardous processes e. g. involving explosives or flammable solvents
- Real-time monitoring of processes, identification of optimal process conditions and characterization of the products using cutting-edge measurement and analytical techniques
- Accelerated reactor development and optimization through CFD-based simulation and fabrication of microfluidic reactors



© photos: Fraunhofer ICT

FRAUNHOFER INSTITUTE FOR APPLIED POLYMER RESEARCH IAP

High-performance fibers for fast cars, organic light-emitting diodes for flexible displays or artificial corneas for eye implants – for over 20 years the Fraunhofer Institute for Applied Polymer Research IAP in Potsdam-Golm has been developing polymers. Our materials and methods cover the entire range of polymer applications. We also create conditions which ensure that the developed methods not only work on a laboratory scale, but also under production conditions. We have been working on biobased and synthetic polymers that meet the growing demands of our partners. They need the end products to be, for example, more durable, more acid and heat resistant, more stable, easier to care for, healthier, more environmentally-friendly, more cost-effective ... and for these products to become easier and more energy efficient to manufacture. At the “Application Center for Innovative Polymer Technologies” which was completed in 2012, we transfer processes for the production of innovative new materials and nanotechnology from laboratory to industry-oriented scale.

MICROENCAPSULATION TECHNOLOGY AT FRAUNHOFER IAP

With over 30 years of experience in microencapsulation, the Fraunhofer IAP is a key partner for questions related to all aspects of microencapsulation. These include synthesis and/or modification of microcapsule wall materials, evaluation of suitable microencapsulation technologies and their adaptation to specific tasks, characterisation of the polymeric wall materials and microcapsules, formulation of microcapsules and their applications.

We offer our know-how and equipment for both, reactive (starting with monomers or prepolymers) and non-reactive (starting with polymers), encapsulation technologies, e. g. polycondensation, polyaddition, in situ polymerization, phase separation, solvent evaporation and extraction, spray drying and spray coating. Natural (e. g. cellulose and starch derivatives) and synthetic polymers (e. g. amino resin, polyurethane, polyamide) are utilized for the synthesis of tailor-made micro-

encapsulated additives and active agents. Possible applications include technical ones (e. g. reactive components such as catalysts and initiators or polymer additives such as flame retardants and pigments) and life science applications (e. g. cosmetic ingredients, food additives, flavour and fragrances).

PARTICLE APPLICATIONS

Based on the solid experience in polymerization technologies, we synthesize tailor-made (micro)particles, which can be used for various applications such as:

- Polylactide particles for laser sintering and laser melting processes
- Latex particles as building blocks for nanotechnology, biomedical applications, diagnostics as well as anti-graffiti protective coatings

OUR OFFER

We offer the following services:

- Feasibility studies on the microencapsulation of solid, waxy and liquid active agents and additives
- Up-scaling of reactive and non-reactive encapsulation processes and determination of suitable conditions for the production on (semi)technical scale
- Supply of up to 30 kg of microcapsules (depends on the microencapsulation process)
- Feasibility studies on microcapsule-containing formulations (e. g. compounding in polymers)

CONTACT

Fraunhofer Institute for Applied Polymer Research IAP

Geiselbergstraße 69 | 14476 Potsdam-Golm

www.iap.fraunhofer.de

www.polymer-analytik.de



Project Management

Dipl.-Ing. (FH) Kathrin Jesse
Phone +49 331 568-1415
Fax +49 331 568-3000
kathrin.jesse@iap.fraunhofer.de



Expert Microencapsulation

Dipl.-Ing. Monika Jobmann
Phone +49 331 568-1213
Fax +49 331 568-3000
monika.jobmann@iap.fraunhofer.de



Expert Microencapsulation

Dr. Alexandra Latnikova
Phone +49 331 568-1207
Fax +49 331 568-3000
alexandra.latnikova@iap.fraunhofer.de

Fraunhofer Institute for Chemical Technology ICT

Joseph-von-Fraunhofer-Str. 7 | 76327 Pfinztal

www.ict.fraunhofer.de



Project Management

Dipl.-Ing. Torsten Müller
Phone +49 721 4640-394
Fax +49 721 4640-111
torsten.mueller@ict.fraunhofer.de



Expert Particle Technology

Prof. Dr. Ulrich Teipel
Phone +49 721 4640-529
+49 911 5880-1471
ulrich.teipel@th-nuernberg.de
ulrich.teipel@ict.fraunhofer.de



Expert of Microfluidic Processes

Dr. Dusan Boskovic
Phone +49 721 4640-759
dusan.boskovic@ict.fraunhofer.de



Expert of Fluidized Bed Technology

Dipl.-Ing. Thomas Heintz
Phone +49 721 4640-372
thomas.heintz@ict.fraunhofer.de